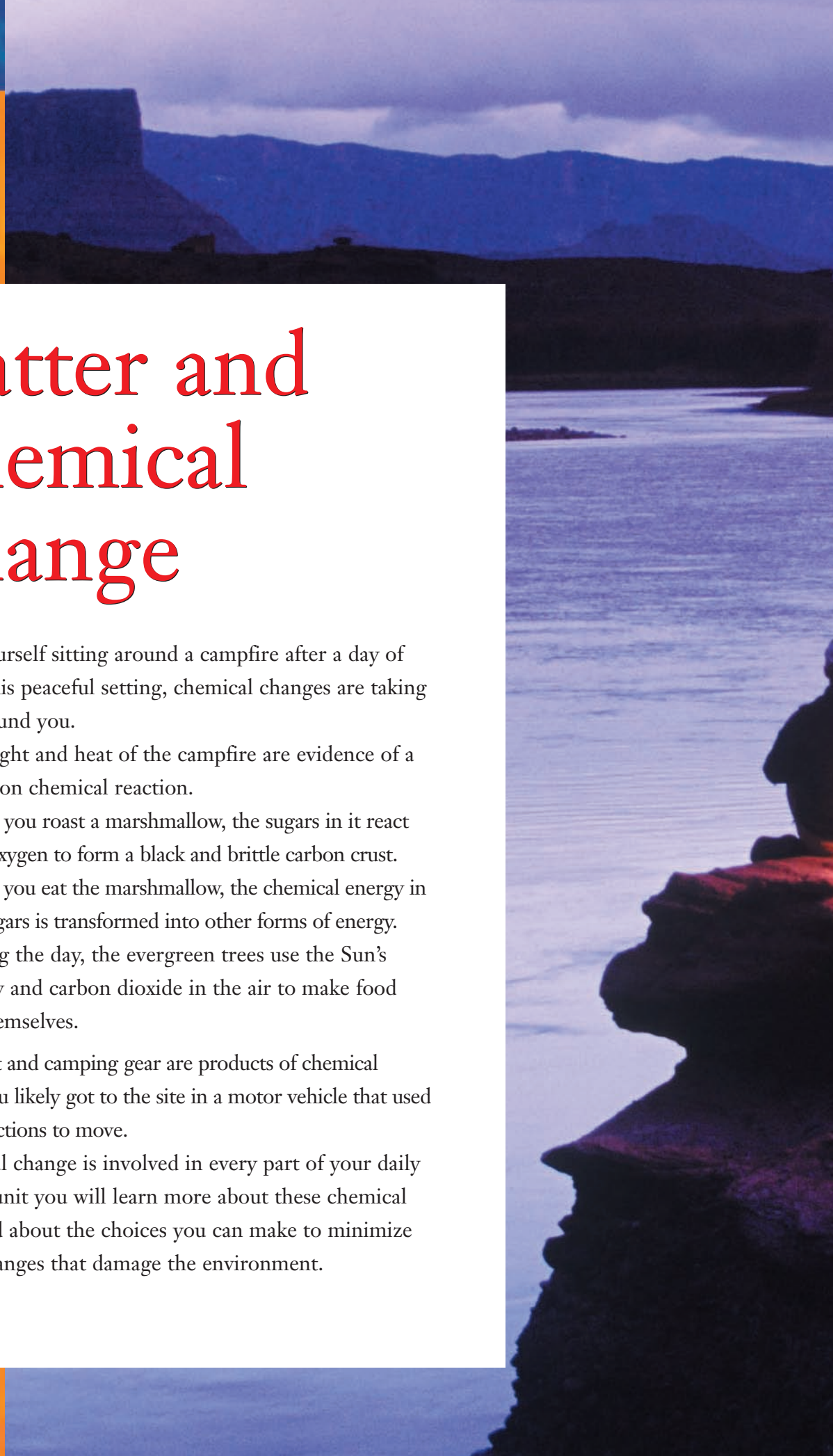
UNIT A



Matter and Chemical Change

Picture yourself sitting around a campfire after a day of hiking. In this peaceful setting, chemical changes are taking place all around you.

- The light and heat of the campfire are evidence of a common chemical reaction.
- When you roast a marshmallow, the sugars in it react with oxygen to form a black and brittle carbon crust.
- When you eat the marshmallow, the chemical energy in the sugars is transformed into other forms of energy.
- During the day, the evergreen trees use the Sun's energy and carbon dioxide in the air to make food for themselves.

Your tent and camping gear are products of chemical reactions. You likely got to the site in a motor vehicle that used chemical reactions to move.

Chemical change is involved in every part of your daily life. In this unit you will learn more about these chemical changes, and about the choices you can make to minimize chemical changes that damage the environment.

Unit Contents

Chapter 1
Useful Chemistry

Chapter 2
Common Reactions in Our Lives

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Types of Chemical Reactions

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CHAPTER 1

Useful Chemistry

Getting Ready...

- How has chemistry made life easier over the past 100 years?
- What would gardening be like without fertilizers and pesticides?
- What do a bathing suit, fire extinguisher, and climbing rope have in common?
- What does a cake rising in the oven have in common with a growing baby?
- How can you use chemicals safely?

These everyday products all have a chemical connection.

Science Log

The chemical paste in a dry cell battery conducts electricity to power a flashlight. Think of some other chemical processes that make useful materials or energy. How would life be different without them? Write your thoughts in your Science Log.

Over the past 100 years, advances in chemistry have provided many consumer products that have helped to change our lives. These advances include the ability to produce synthetic materials that have helped us reduce our need for natural materials. Instead of wool from sheep and fur from wild animals, we now use nylon, polyester, and other synthetic fibres. This has helped reduce the risk of extinction for many fur-bearing species.

Synthetic dyes have made it possible to produce dramatic colours not possible with natural dyes. For example, the orange colour used on hunting vests and clothing for emergency crews is synthetic. So are most of the colours that were used in making textiles during the twentieth century.

Chemistry has also given us many of the conveniences we take for granted. Products like detergent, Teflon™, and margarine exist because of what society has learned about chemistry.

Chemicals have changed the way hair stylists work. This hairdresser is using ceramic tube hair curlers to provide tight curls during the 1940s.

What You Will Learn

In this chapter you will learn:

- how new materials have changed everyday life over the past 100 years
- about some chemical changes involved in cooking, cleaning, and gardening
- about the role of chemicals in the workplace
- how to interpret safety information at work and home

Why It Is Important

- Everyday life has changed a lot in the past 100 years. Many of the things we take for granted today were unimaginable when your great-grandparents were your age. Our growing knowledge of chemistry has made many of these processes and products possible.

Skills You Will Use

In this chapter you will:

- investigate how modern chemicals and processes have changed daily routines
- investigate chemical changes involved in cooking, cleaning, gardening, and cosmetics
- read and interpret HHPS and WHMIS symbols
- read and interpret an MSDS

Starting Point ACTIVITY

Old-fashioned Ice Cream

Make ice cream simulating a process that could have been used 100 years ago.

Safety Precautions

- Clean up the work area and wash your hands thoroughly at the end of the activity.
- Never eat anything that has been made in a science room or laboratory.

What You Need

2 resealable freezer bags (1 small, 1 large)

100 mL ice-cream mix

500 mL crushed ice

100 mL salt

thermometer

measuring cups

What to Do

1. Pour 100 mL of the ice-cream mix into a small resealable freezer bag.
2. Squeeze the air out of the bag. Seal it.
3. Mix half the ice (250 mL) and half the salt (50 mL) together thoroughly in the large freezer bag.Take the temperature.
4. Place the small freezer bag inside the bag with salt and ice, and pack the ice-salt mixture around the smaller bag.
5. Add the rest of the ice and salt.
6. Seal the large freezer bag. Flip it every 2 minutes for about 10–15 minutes or until the ice-cream mix has hardened.
7. Take the temperature of the ice-salt-water mixture.
8. Do the analysis provided by your teacher.

1.1 Chemistry Then and Now

Figure 1.1 Farmers and gardeners in the nineteenth century used manure from their livestock to fertilize the crops and gardens. Some modern farmers still use manure, but most use fertilizers produced in the chemical laboratory. Instead of relying on animal and plant waste of varying quality, chemists mix raw chemicals (such as potassium nitrate) together to make fertilizer. These manufactured fertilizers can be more effective than natural ones because they are designed for specific crops and specific field conditions. On the other hand, manure returns valuable organic matter to the soil.

READING Check

How do chemists help modern farmers?

Chemistry on the Farm

If you had been alive in Canada 150 years ago, you probably would have been living on a farm. As well as feeding animals, shovelling manure, and driving a team of horses, your jobs would have included pulling weeds and picking insects off the crops in your garden.

Today, only about 2.5 percent of people in Canada live on farms. Advances in chemistry and technology enable modern farmers to produce a lot more food with less human labour. Many farms have automatic feeders and barn cleaners. Teams of horses have been replaced by tractors and other machinery that allow each farmer to do the work of several people.

In addition, **synthetic** or human-made chemicals produced in a lab have reduced the amount of work farmers have to do. Instead of pulling weeds and killing insects, farmers now use synthetic **pesticides**. There are two common kinds of pesticides. **Herbicides** kill unwanted plants, and **insecticides** kill unwanted insects.

The use of chemical pesticides and synthetic fertilizers means the land can produce more food. Advances in technology and chemistry help the produce survive the trip to the consumer. In addition, the produce lasts longer on the grocery store shelves and in your cupboard.

DidYouKnow?

Pesticides such as Dursban™ are commonly used to control insects. Dursban™ is a form of organophosphate. It works by interrupting the electrochemical process that nerves use to communicate with muscles and with one another. A lethal dose kills insects. Farmers have to handle the pesticide with great care because it can also damage the human brain and central nervous system.

Chemistry for Cleaning

One hundred years ago, farmers made their own soap using ashes from the cooking stove and natural fats from various animals living on the farm. Similar methods have been used for thousands of years.

In the past, beef fat was usually used when making soap. Today, some manufacturers have replaced some or all of the animal fat with plant oils. For example, coconut oil may be used to make a soap that has a nice scent and cleans very well. Other ingredients are sometimes added to provide more suds or help soften skin.

Many cleaners include strong bases. Bases produce soap when they react with the fatty acids in grease. Soap consists of a two-ended molecule. One end of the molecule dissolves in grease and the other dissolves in water. This reaction enables us to wash away grease.

READING Check

How does modern soap differ from the soap made 100 years ago?

Find Out ACTIVITY

How Can You Make Soap from Natural Substances?

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Safety Precautions

- Lye is extremely corrosive. If you get it on you, hold the body part under cool running water for 10 minutes. Inform your teacher.
- Use tongs to handle hot glassware.
- Hot grease can cause severe burns.
- Clean up the work area and wash your hands thoroughly at the end of the activity.

What You Need

lye ($NaOH_{(s)}$) lard or shortening
scale hot plate
2 beakers (250 mL) tongs
water plastic knife
50 mL graduated cylinder small plastic
stirring rod container with lid

What to Do

1. Measure 3.4 g of lye.
2. In one beaker, dissolve the lye in 15 mL of water. **CAUTION:** The mixture will heat up as you stir.
3. Allow the solution to cool while you measure 23 g of lard or shortening.
4. Heat the lard or shortening in the second beaker on a hot plate set at medium.
5. Using tongs, carefully set the beaker of melted lard or shortening aside until the contents are at room temperature but still liquid.
6. Slowly pour the dissolved lye into the lard or shortening.
7. Stir the mixture constantly for 15 minutes. Allow the mixture to stand, and then mix again every 15 minutes until the mixture thickens.
8. Pour the mixture into a small plastic container.
9. Cover the container and set it aside overnight.
10. Carefully, use a knife or ruler to loosen the edges of the soap from the container.
11. Do the analysis provided by your teacher.

Chemistry and Synthetics

One of the major changes in the past 100 years has been the development of **synthetic fibres** or threads. One hundred years ago, clothing was made from natural fibres such as cotton, flax, wool, and silk.

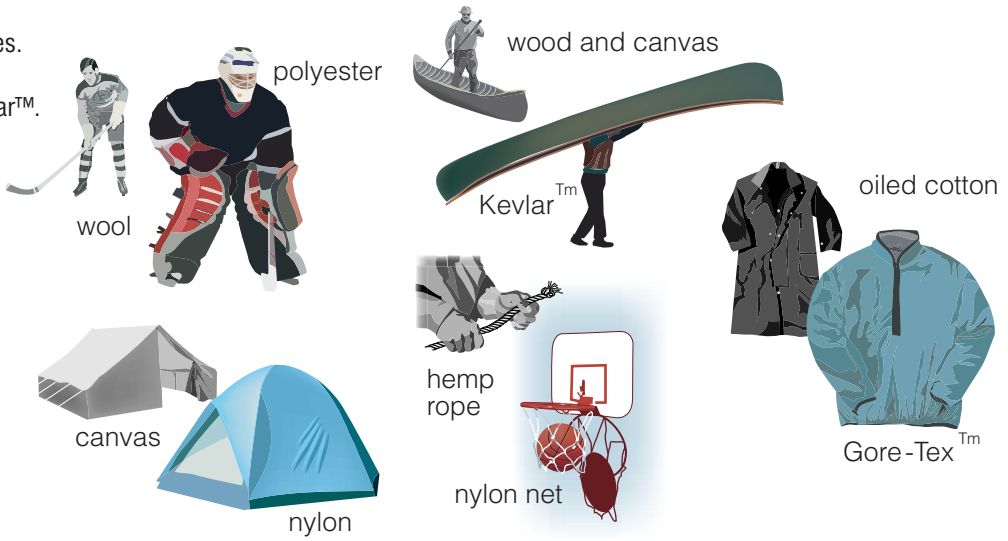


Figure 1.2 Identify the natural and synthetic materials in these pictures. Note which items might be made from polyester, Gore-Tex™, or Kevlar™.

- The downy, white fibres found in the seed pod of the cotton plant are used to make cotton thread. This is woven into cotton material.
- The stems of the flax plant are processed into threads that are woven to make linen.
- The woolly coats of animals such as sheep and goats are spun into wool. This is woven into woolen material.
- Fibres from the cocoons of silk worms are made into silk thread, which is woven into silk cloth.

Today, we still use each of the natural forms of cloth. In addition, many new and exciting type of fibres have been developed in the chemistry laboratory.

The first of these synthetic fibres was nylon. Nylon is made from coal, water, and air. It was first discovered by Wallace Carothers in the 1930s. When nylon was first made, scientists did not see any practical use for the material until some chemists at the company were playing games to see how far they could stretch it. They found that the stretched nylon fibres were very strong and silky. By 1939, nylon was used to make stockings.

Other synthetic fibres include polyester, Gore-Tex™, and Kevlar™.

DidYouKnow?

Polyester is a fibre that bounces back into shape quickly and does not absorb very much moisture. This material is used to make clothes that dry quickly and do not need ironing.

READING Check

Identify one natural and one synthetic fibre. How is each made?

Try This!

Use tweezers to obtain strands of each of the following materials: cotton, linen, wool, silk, nylon, polyester, Gore-Tex™. How are synthetic and natural fibres the same? How do they differ?

Check Your Understanding

1. How have chemicals made modern farming easier than it was 100 years ago?
2. How has the process of making soap changed over the past 100 years?
3. Name two synthetic and two natural fibres. Describe at least two advantages of synthetic fibres.

Key Terms

synthetic
pesticides
herbicides
insecticides
synthetic fibres

1.2 Plastics, Polymers, and Alloys

Another major change over the past 100 years has been the development of **synthetic polymers**. Polymers are a type of compound that occurs in nature. For example, the silk in spider webs and the sap from rubber trees are two natural polymers.

During the past 75 years, chemists have made synthetic polymers in the laboratory. The great thing about synthetic polymers is that scientists can develop different ones with physical characteristics that meet a particular need. You know many of these synthetic polymers as types of plastic.

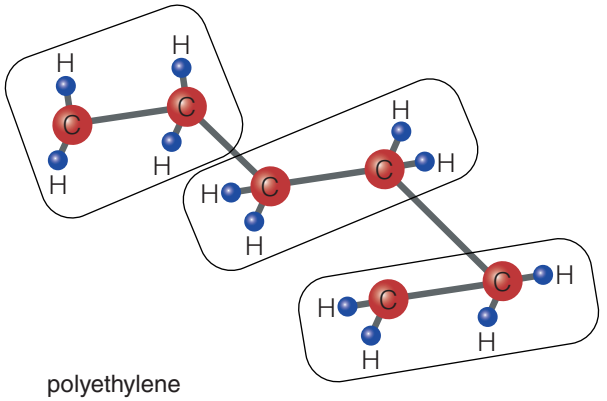
Table 1.1 shows some synthetic polymers, their properties, and how they are used. Read the descriptions and identify ways that you use each of them.

READING Check

Synthetic polymers have changed the way we live. Identify three that play a role in your daily life, and explain how you use each one.

Table 1.1 Synthetic Polymers and Their Uses

Polymer	Significant Properties	Uses
neoprene	rubbery, porous, insulating, does not react readily with other chemicals	shoe soles, hoses, wet suits
polyethylene	can be easily formed into lightweight containers	milk jugs
polystyrene	does not absorb water, poor conductor	styrofoam cups, insulation
polyurethane	flexible, fibrous, does not absorb water	upholstery, clothing



polyethylene

Figure 1.3 A polymer is a giant molecule made up of many small and identical sub-molecules. A polymer is put together like a string of beads. In the case of polyethylene, each bead consists of two carbon atoms and four hydrogen atoms. In this visual, the circled areas show one unit of the polyethylene polymer.

Off the Wall

Synthetic polymers can help you see. The lightweight lenses in today's glasses are made from polycarbonates. These lenses are much lighter and can be made much thinner than old-fashioned glass lenses.

Find Out ACTIVITY

Make Your Own Polymer

In this activity, you will make a synthetic polymer using substances you can find at home.

Safety Precautions

- Clean up the work area and wash your hands thoroughly at the end of the activity.

What You Need

disposable cup
stirring rod
graduated cylinder
5 mL white glue
5 mL water
10 mL borax solution

What to Do

1. Mix 5 mL of water with 5 mL of white glue in a disposable cup.
2. Add 10 mL of borax solution to the glue mixture and stir for 2 min.
3. Roll the lump in your hands until it is not sticky anymore.

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

What Did You Find Out?

1. **(a)** Reshape the putty into at least three forms.
   (b) What happens when you try to bounce or stretch the putty?
   (c) What else can you do with it?
2. How have the physical characteristics of the substances changed throughout the activity?
3. This product was around for a long time before anyone thought of using it as anything except a toy. Suggest two or three other uses for it.

READING Check

Explain what an alloy is. Give one example.

Alloys

Have you ever wondered why stainless steel does not rust? In the past, cooking utensils were made of iron that eventually rusted. Modern kitchen utensils are made from several metals mixed to look like one metal. This type of mixture is an **alloy**. Alloys have properties of the original metals that make up the alloy.

Figure 1.4 Many kitchen utensils are made of stainless steel. Stainless steel is a mixture of iron, chromium, nickel, and carbon.

Using Alloys

Many of the products you use today — from cars to jewellery — are made from alloys. Steel for buildings is an alloy of iron and chromium. Cars made from steel in the early 1900s were very strong, but they were heavy and prone to rusting. The steel in today's cars is also mixed with chromium. This steel alloy has the strength and durability of iron, plus chromium's resistance to rusting.

A new type of steel has been developed called *superplastic* or ultrahigh-carbon steel. This new steel contains more carbon than was used in previous steels. Ultrahigh-carbon steel can be stretched to 100 times its length without breaking. Earlier forms of steel could be stretched to only 1.5 times their original length.

Figure 1.5 Silver and copper in these gold rings provide strength. The gold jewellery you wear is actually a gold alloy — a mixture of gold and another metal, such as silver, copper, zinc, or nickel.

This new steel can be used to make structures that are light but still very strong.

Pure gold is very soft and gets damaged easily, so most jewellery is made with alloys. For example, 14k gold is actually an alloy of gold, silver, and copper.

READING Check

How have alloys changed the transportation industry?

Try This!

Put a few drops of water on iron and on stainless steel. Wrap the items in damp paper towelling and leave overnight. Observe the surface of the materials. Describe any changes. What is the advantage of stainless steel over iron?

DidYouKnow?

Brass is an alloy made from copper and zinc. Musical instruments such as trumpets, horns, and cymbals are usually made from brass.

Internet CONNECT

www.mcgrawhill.ca/links/science.connect2

Most jewellery is made from alloys. To learn about some of the alloys used in jewellery, go to the above web site. Then go to Internet Connects, Unit A, Chapter 1, and then to Precious Metals.

Key Terms

synthetic polymers
alloy

Check Your Understanding

1. What metals are found in stainless steel utensils? How would your life be different if kitchen utensils were not made from stainless steel?
2. In the winter, you choose clothes with fabrics that will keep you warm.
   (a) What materials keep you warm today?
   (b) What materials would you have used 100 years ago?
3. Synthetic polymers are used in many products. Name three synthetic polymers and briefly explain how they have changed daily life.

1.3 Chemistry at Home

Figure 1.6 Many hazardous substances are found at home. Some of these substances are stored in a cupboard to keep them away from young children. Others are kept in special containers that prevent accidental poisoning. Almost all of these products have safety warnings on their labels. Hazardous Household Product Symbols (**HHPS**) are designed to be easy to understand. The shapes that outline the pictures are designed to look like road signs.

Chemicals in the Cupboard

If you did a quick survey of the cupboards in your kitchen, bathroom, and laundry room, you would probably find all-purpose cleaners, toilet-bowl cleaners, and a variety of other cleaning products. Cleaners usually contain substances that are reactive. They start chemical changes that break down the dirt and make cleaning less strenuous.

Drain cleaners, for example, often contain highly corrosive substances such as sodium hydroxide. Sodium hydroxide is a base used to make drain and oven cleaners. Bases like sodium hydroxide help clean clogged drains by breaking down the proteins (such as skin cells and hair) and animal fats that cause the problem. Heat is given off, which helps melt the grease.

Table 1.2 names other common household cleaners and explains how each works.

Table 1.2 Common Chemicals and How They Clean

Chemical	Where Found	How It Cleans
muriatic acid (hydrochloric acid)	• steam-iron cleaner	reacts with lime (scaly buildup) to form a soluble product
acetone	• nail polish remover	dissolves nail polish so it can be wiped away
methanol (wood alcohol)	• paint solvent	dissolves the paint

READING Check

Explain how one cleaner uses chemical change to clean. What is the negative side of this chemical change?

Try This!

Many of today's furniture polishes include hazardous substances. In the nineteenth century, people polished their furniture using products that were less hazardous. You can make your own furniture polish by mixing 20 mL of lemon juice with 1 L of mineral oil. Spray or wipe this mixture onto wooden furniture and wipe it with a dry cloth.

The mineral oil will seep into the wood and help prevent dust from sticking to the wood. The lemon juice will help speed up the absorption.

DidYouKnow?

When you pour hydrogen peroxide on a cut, it will start to foam. That is because the hydrogen peroxide turns into water and oxygen — a chemical change. The foaming helps remove small particles that could enter the skin and cause infection. The chemical reaction also kills bacteria that enter the wound.

Figure 1.7

Chemistry and Cooking

A knowledge of chemistry is important to chefs, bakers, and cooks. Knowing how different ingredients react allows them to control chemical reactions. For example, bakers may use yeast to make bread. Yeast is a single-celled organism that needs food, warmth, and moisture to thrive. It converts its food (sugar and starch) into carbon dioxide and alcohol. Carbon dioxide bubbles make baked goods rise.

A mixture of vinegar and baking soda will also produce carbon dioxide gas. Sometimes bakers use this mixture to make baked goods rise. Sponge toffee, for example, is a mixture of vinegar, baking soda, and sugar.

Figure 1.8 Yeast is responsible for the chemical reaction that makes bread rise. This knowledge helps bakers produce different kinds of bread.

DidYouKnow?

Cooking involves many other chemical reactions. For example, citrus fruits and rhubarb react with kitchen utensils made of aluminum. The acid in these foods reacts with the aluminum in the utensils and produces hydrogen gas. This reaction will cause the utensil to become corroded and no longer useful.

To avoid such a reaction, many chefs use kitchen utensils made from stainless steel. Stainless steel will not react with acid.

The inside of an aluminum soft-drink can does not react with the acid in the soft drink because the aluminum has been coated with a plastic polymer that keeps the pop from coming into direct contact with the aluminum.

Figure 1.9

Try This!

Test whether yeast is active by dissolving15 mL of dried yeast and 5 mL of white sugar in 250 mL of warm water. Observe the mixture for several minutes. What happens?

READING Check

Describe one chemical change used in cooking. How is it used?

DidYouKnow?

In 1897, J.J. Thomson found that there were small electrons embedded in the atom like chocolate chips in a chocolate chip cookie or raisins in a plum pudding. Think & Link Investigation 1–A on page 14 demonstrates something else chocolate chip cookies and chemistry have in common.

Chemist's Recipe for Chocolate Chip Cookies

Cooks, chefs, and bakers use chemistry every day. They work with chemical compounds and polymers, use specialized tools to measure the volume and mass of ingredients, apply or remove thermal energy, and cause chemical and physical changes to matter. In this activity, you will investigate the chemistry involved in baking chocolate chip cookies.

Safety Precautions

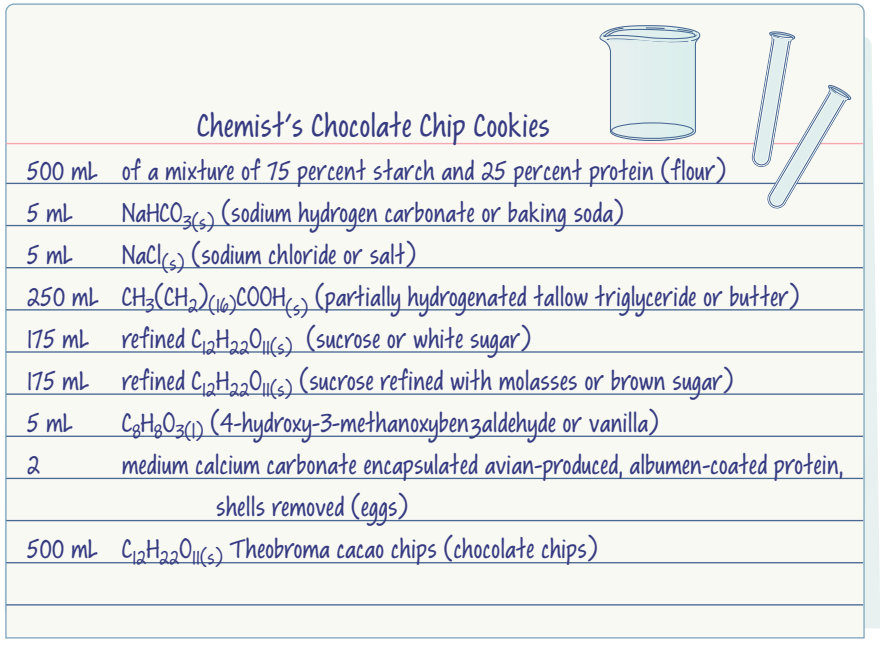
- Never eat anything that has been made in a science room or laboratory.
- Be aware that some ingredients can cause allergic reactions in some people.
- Wash your hands and clean up the work area at the end of the activity.

Apparatus

volumetric measuring devices (measuring spoons and cups)
2 reaction vessels (2 L) (mixing bowls)
wooden or plastic mixing utensils
metal reaction plate (cookie sheet)
device that will convert electrical energy into thermal energy
cooling rack

Materials

See list on recipe card.


Chemist's Chocolate Chip Cookies
500 mL of a mixture of 75 percent starch and 25 percent protein (flour)
5 mL $NaHCO_{3(s)}$ (sodium hydrogen carbonate or baking soda)
5 mL $NaCl_{(s)}$ (sodium chloride or salt)
250 mL $CH_3(CH_2)_{(16)}COOH_{(s)}$ (partially hydrogenated tallow triglyceride or butter)
175 mL refined $C_{12}H_{22}O_{11(s)}$ (sucrose or white sugar)
175 mL refined $C_{12}H_{22}O_{11(s)}$ (sucrose refined with molasses or brown sugar)
5 mL $C_8H_8O_{3(l)}$ (4-hydroxy-3-methanoxybenzaldehyde or vanilla)
2 medium calcium carbonate encapsulated avian-produced, albumen-coated protein, shells removed (eggs)
500 mL $C_{12}H_{22}O_{11(s)}$ Theobroma cacao chips (chocolate chips)

What to Do

1. Use the wooden mixing utensil to cream the partially hydrogenated tallow triglyceride, 4-hydroxy-3-methanoxybenzaldehyde, and both types of $C_{12}H_{22}O_{11(s)}$ together in one of the reaction vessels.
2. Add the calcium carbonate encapsulated, avian-produced, albumen-coated protein, shells removed. Mix well.
3. In the second reaction vessel, combine the mixture of 75 percent starch and 25 percent protein, sodium chloride, and sodium hydrogen carbonate. Add to the creamed mixture.
4. Stir in the Theobroma cacao chips.
5. Spoon the final mixture onto a metal reaction plate.
6. To allow for the chemical reactions to take place, insert the metal reaction plate into the thermal energy producing device for 8 to 10 minutes and bake at 463K (190°C) until golden brown.
7. When complete, place the products of the chemical reactions on a cooling rack and allow the product to come to equilibrium.
8. Do the analysis your teacher provides.

Check Your Understanding

Key Terms

HHPS

1. Many household cleaners rely on chemical changes to do their work. What chemical change occurs when you add drain cleaner to a clogged pipe?
2. Identify three chemicals commonly found in household cleaners and describe how each of these chemicals helps to clean.
3. **(a)** Yeast helps bread to rise. Explain the chemical change that yeast produces and how this makes bread rise.
   (b) If you wanted a flat bread, would you use more or less yeast? Explain.

1.4 Chemistry at Work

Even 100 years ago, chefs were using chemistry to do their work. So were blacksmiths and welders. For example, the welder in Figure 1.10 knows that pieces of steel must be heated to a very high temperature to melt them. Only then can they be welded together. A chemical change involving acetylene gas and oxygen produces enough heat to melt steel.

Figure 1.10 The acetylene torch uses a chemical reaction that produces carbon dioxide, water, and enough energy to melt steel.

In the early 1900s, blacksmiths served as both mechanics and welders. When they were not shaping metal, they often experimented with different ways to combine metal and other materials.

Today chemistry is used in every workplace. The list below provides some examples. Consider any place where you or members of your family work. What chemistry is involved?

Automotive Repair Shop — Paints, fillers, and cleaners all involve chemical reactions. Special car paint protects metal car bodies from rusting. Waxes and polishes protect that paint. When the paint gets faded by the Sun, special waxes may remove tiny amounts of paint to restore the shiny appearance.

Hair Salon — Just about everything but the scissors involves a chemical change. This includes colorants, curling solutions, shampoos, and conditioners.

Office — Hazardous chemicals are common in inks, toner cartridges, correction fluid, and the fire retardants in paper, upholstery, and carpets.

Construction Site — Hazardous chemicals are found in demolition explosives, wood preservatives, paints for finishing, and solvents for cleaning up. Many solvents used to clean grease stains or wash windows include ammonia. Ammonia works by dissolving grease, wax, and window dirt.

READING Check

Every workplace uses some type of chemical reaction. Name one chemical reaction used where you work part-time or in your classroom.

Cosmetic Chemistry

Figure 1.11 Do you use shampoo that adds texture to your hair? If so, you are putting plastic in your hair. Such shampoos simply cover hair with plastic resins. The plastic resins make the hair thicker, which appears to improve its texture.

Before 1938, most people cleaned their hair with soap. Have you ever used bar soap on your hair? It probably left your hair dull and rough — not really the look you wanted.

This happens because soap is a base that breaks down protein such as hair. Soap also reacts with calcium in water, leaving a scum layer on your hair. This layer makes hair dull and difficult to comb.

Even before 1938, hair stylists knew how to deal with this layer of scum. They used an acid rinse made from vinegar or lemon juice to dissolve the scum, making the hair shine again.

When you buy shampoo, you are buying a synthetic detergent that will help wash oil and dirt from your hair. Dish detergents wash grease and dirt from your dishes. In the next activity, you will determine which detergents clean dishes best.

READING Check

Soap will clean your hair, but why won't soap make your hair shiny and smooth?

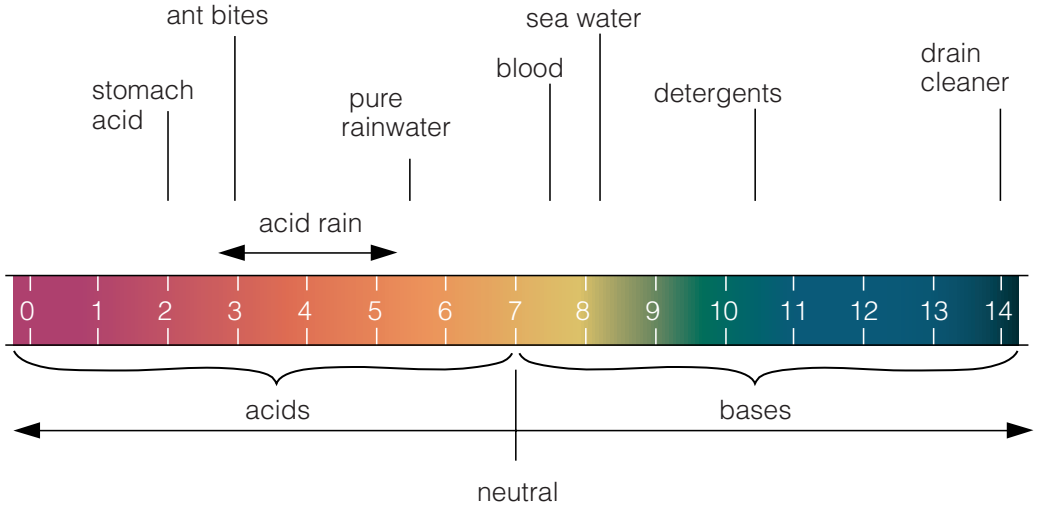


Figure 1.12 This diagram shows the pH of some common substances. Where do the shampoos you use in Design & Do Investigation 1–B fit on this scale?

DESIGN & DO

INVESTIGATION 1-B

SKILLCHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Which Dish Detergent Is Best?

Liquid dishwashing detergent has special ingredients intended to:
- dissolve oil and grease from the surface of dishes: and
- keep oil and grease suspended in the wash water.

In this activity, you will design an investigation that will determine which liquid dish detergent works the best.

Challenge

Design and construct an investigation that will examine the ability of a liquid dishwashing detergent to remove grease from a clear plastic glass.

Safety Precautions

- Dish detergent can cause skin or respiratory irritation.
- Do not get dish detergent in your eyes. If you do, flush with water for 10 min.
- Clean up the work area and wash your hands thoroughly at the end of the investigation.

Apparatus

4 large beakers

Materials

4 different brands of liquid dish detergent (approximately 1 mL of each)

4 clear plastic drinking glasses

4 mL tomato spaghetti sauce (or other source of grease)

Design Criteria

A. Test the four liquid dish detergents to see which is best at removing grease from a plastic drinking glass.

B. Develop a procedure that identifies:
- one manipulated variable;
- the responding variable: and
- the other variables that you control.

C. Develop criteria to evaluate how well each liquid dish detergent removes the grease from a plastic glass. For example, you might want to hold the glass up to the light and assess its colour before and after washing.

Plan and Construct

1. Identify what materials your group will need to carry out this investigation.
2. Identify the manipulated variable, the responding variable, and all of the other variables you will control.
3. Write out all of the steps that you will follow in this investigation. Include the safety precautions.
4. List the criteria you will use to evaluate the cleaning ability of the dish detergent. The criteria that you select should allow you to rank the detergents from best to worst.
5. Create a data table to record your results.
6. Record your results and rank the detergents based on the tests your group performed.

Evaluate

1. Is there any difference between the detergents tested?

2. Did your evaluation criteria help you rank the detergents?

3. Which detergent worked best? Explain your answer.

4. Why do dish detergents include an active ingredient that dissolves oil and grease and keeps it suspended in water?

Make-up and Face Cream

READING Check

How is chemistry useful in the development of cosmetics? Explain.

Cosmetics have been around for thousands of years. Some of these cosmetics are harmless, but others are not.

Many cosmetics are tested on animals before being used on people. Researchers study how much the animals are affected before allowing the material to be used on humans.

Today, many groups oppose the use of animals in testing cosmetics. As a result, many manufacturers advertise that their products have not been tested on animals. Knowledge of chemistry helps manufacturers control chemical reactions. Use the next activity to make your own skin cream.

Find Out ACTIVITY

Make a Skin Cream

Cosmetic manufacturing is big business today. Each year, consumers spend billions of dollars on everything from creams and oils to shampoos and shaving cream. Many of these products use chemical changes to keep you looking good.

In this activity, you will make a hand cream using readily available materials. As the skin ages, the outer layers become thinner and dryer. This tends to exaggerate fine lines and wrinkles.

Various skin creams will help make the skin look smoother by putting moisture back into the skin and creating a barrier to prevent evaporation. Of course, the best way to make your skin look good is to eat a proper diet and drink plenty of water.

Many skin creams are emulsions of oil, water, and wax. An emulsion is a mixture of two liquids, such as oil and water, that normally do not mix. If you shake oil and water together, you get an emulsion that is unstable and will separate quickly.

An emulsifier can be used to make the emulsion more stable. An emulsifier works by coating the droplets of one liquid so they stay suspended in the other liquid.

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Safety Precautions

- Clean up the work area and wash your hands thoroughly at the end of the activity.

What You Need

60 mL distilled water

120 mL mineral oil

1 g borax

30 mL grated beeswax

hot plate and wire mesh screen

ice bath or access to a refrigerator

100 mL beaker

250 mL beaker

1000 mL beaker or small saucepan

100 mL graduated cylinder

stir stick or plastic spoon

What to Do

1. Use the graduated cylinder to add 60 mL of distilled water to the 100 mL beaker.
2. Dissolve the borax in the distilled water and set aside.
3. Use the graduated cylinder to add 120 mL of mineral oil to the 250 mL beaker. Add the beeswax to the mineral oil.

4. Pour approximately 100 mL of tap water into the 1000 mL beaker. Place this on the hot plate and gradually warm the water. This is the hot water bath.
5. Carefully place the 250 mL beaker of oil and wax mixture into the hot water bath. Heat the mixture for approximately 10 minutes or until the beeswax melts. Describe the appearance of this mixture.
6. Put on heat-proof gloves and carefully remove the melted oil-wax mixture from the hot water bath. Remove the hot water bath from the hot plate. Let the hot plate cool down before doing the next step.
7. Place the 100 mL beaker containing the borax solution on the hot plate and bring it almost to a boil. Describe the appearance of this mixture.
8. Slowly add the borax solution to the oil–wax mixture. Stir this mixture continuously. Describe the appearance of this mixture.
9. Cool the beaker containing the oil, wax, water, and borax mixture in an ice bath or the refrigerator.
10. Check the beaker every 5 minutes for the remainder of the class. Record the appearance of the mixture.
11. Do the analysis provided by your teacher.

The Key to Chemical Safety

The acid from a car battery will burn your skin. That is why people wear gloves when handling a car battery.

How do you know what safety precautions to use when handling a substance you have never used before? The best way is to read the label.

If the dangerous substance is found in a workplace — including a school, restaurant, or repair shop — you will find a **WHMIS** label on the container. WHMIS stands for Workplace Hazardous Materials Information System. It provides detailed information on how to store, handle, and dispose of dangerous substances at work.

If you are working with hazardous materials, you should also check the **MSDS** or Material Safety Data Sheet. The MSDS provides detailed information that will not fit on the product label.

Figure 1.13 Look for these WHMIS symbols on any product you use at work.

DidYouKnow?

$NaCl_{(s)}$ is a substance you use every day. You even eat it!

$NaCl_{(s)}$, or table salt, can be hazardous because its dust causes respiratory irritation. People who work around salt dust wear a self-contained breathing apparatus. Because salt reacts dangerously with some classes of chemicals, large amounts of salt must be disposed of as hazardous waste.

READING Check

What do the initials WHMIS stand for? Why should workers know how to use WHMIS?

Check Your Understanding

1. Choose two different workplaces and identify five hazardous substances you would find in each one.
2. Why is it important for workers at a restaurant to understand WHMIS?

Key Terms

WHMIS
MSDS

CHAPTER

1 Review

Key Terms

synthetic
pesticides
herbicides
insecticides
synthetic fibres
synthetic polymers
alloy
HHPS
WHMIS
MSDS

Reviewing Key Terms

If you need to review, the section numbers show where these terms were introduced.

1. What is a pesticide? How do pesticides help crops grow? (1.1)

2. Define synthetic. (1.1)

3. What do the substances in this drawing have in common? How are they different? (1.1)

4. Define synthetic polymer and give two examples. (1.2)

5. An alloy is an important type of mixture. Name an alloy and list the elements that make it up. (1.2)

6. Many household products have HHPS on their labels. What does HHPS stand for? (1.3)

7. What three types of information would you find on a WHMIS label? (1.3)

8. When it is used in a workplace, should table salt ($NaCl_{(s)}$) have an MSDS? Explain why or why not. (1.4)

Understanding Key Ideas

Section numbers are provided if you need to review.

9. Over the past 100 years, how has chemistry changed the way gardening is done? (1.1)

10. Describe three ways in which synthetic fabrics benefit your daily life. (1.1)

11. How does knowing about chemistry help bakers? (1.2)

12. Explain why aluminum pots darken when rhubarb is cooked in them. (1.3)

13. **(a)** Review the section on alloys and synthetic fibres. What do they have in common?

(b) What are the advantages of using alloys and synthetic fibres in commercial products? (1.2)

Developing Skills

14. Use a table similar to the one shown here to list two uses for each of the following synthetics and one natural substance that each replaced. (1.1)
(a) nylon
(b) Teflon™
(c) Kevlar™

Synthetic Polymer	Two Uses	Natural Substance Replaced

15. What safety equipment would you wear when handling a substance that had this WHMIS symbol on it? (1.4)

Problem Solving/Applying

16. A farmer's field is infested with weeds and has poor soil. What two types of synthetic substances would help the farmer grow crops in this field? (1.1)

17. Describe the difference between natural and synthetic medicines. (1.1)

18. Design a label for a new product people will use in their homes. This product is highly flammable and somewhat corrosive. Be sure to include the necessary HHPS. (1.3)

Critical Thinking

19. Cars made in the early 1900s were made from steel. Modern cars often contain polymers and alloys. What are some advantages of using these synthetics? (1.2)

20. Many cleaners contain hazardous substances. How could you minimize risk when storing cleaners at home? (1.3)

Pause & Reflect

1. The use of chemicals and chemical processes has had enormous effects on society. Some of these effects are positive and some of them are negative. Use what you have learned in this chapter to help you decide whether modern synthetics have helped or hurt society more. Provide examples to support your answer.

2. Ceramic tiles are found on the space shuttle. The tiles help protect the shuttle from burning up on re-entry into Earth's atmosphere. In a group, brainstorm other products of chemistry that benefit society. Explain the benefit of each product.